THE USE OF A HORMONE-LIKE SUBSTANCE FOR BEEF CATTLE

by

KENNETH EARL VISSER

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INTRODUCTION

During the past few years stilbestrol has been recognized as a growth stimulating factor in beef fattening rations. For a long period of time, endocrinologists have realized the influence of various hormones on the regulation of growth and other physiological functions of animals. Due to the high cost of natural hormones, little research was done on feeding them to cattle.

A, B-diethyl-4,4'-stilbenediol is the chemical formula for diethylstilbestrol. It is a white, crystalline powder, insoluble in water but soluble in most organic solvents. In the late 1930's the synthetic compound diethylstilbestrol was synthesized. This was one of the discoveries that made it practical to continue further feeding studies of the estrogenic hormone in the ration of beef cattle and sheep. Diethylstilbestrol or stilbestrol, as it is more commonly called, is a synthetic steroid compound, but does not have the steroid structure. It has an effect on the animal body similar to that of the natural estrogenic hormone produced by the ovaries of the female. It is used as a substitute for the natural hormones of this type. It is more readily absorbed from the alimentary canal than most of the natural hormones and hence is suitable for oral use. Stilbestrol is administered either orally or by implantation in part of the animal's body that will not be part of the edible carcass.

Since diethylstilbestrol has been synthesized, extensive studies have been and are being made by beef and sheep investigators on its use in livestock feeding. Some of the studies that have been undertaken by a number of experiment stations are the method of administration, rations best suited for the supplementation of the estrogenic hormone, effect on rate of gain and feed efficiency, physiological or anatomical responses such as altered sexual behavior, mammary stimulation, high tail heads and its effect on carcass quality on both females and castrate males. Some research has been done by a number of workers on the residual estrogenic content of the edible meat of animals treated with stilbestrol.

This experiment was conducted to obtain information on (1) the value of stilbestrol in the wintering ration of beef calves, (2) the carry over effect during grazing and fattening, (3) the value of stilbestrol in both the wintering and fattening ration of beef calves, (4) the effect of stilbestrol on feed utilization, and (5) the effect of stilbestrol on carcass grade.

REVIEW OF LITERATURE

Estrogenic Content of Various Feeds

Pastures vary widely in their ability to maintain milk production in dairy cattle. Livestock owners have sometimes noted an increase in milk production depending on the type of pasture and stage of development of the plants being grazed. It was noted by shepherds in Western Australia that subterranean clover

contained sufficient estrogenic activity to adversely affect the reproductive performance of the grazing ewes and cause genital and mammary stimulation in wethers, Bennetts, et al. (1946). The recent increased use of hormones in livestock feeding has made it desirable to determine the estrogenic activity of common livestock feedstuffs and to attempt to assess their possible effect on the physiology of the animals that consume them, according to Pieterse and Andrews (1956b).

In other cases it has been recognized that pastures may actually stimulate mammary function and may improve reproductive efficiency. These desirable properties of forage have been explained in terms of a variety of factors such as species of plant, stage of growth, seasonal climatic effects, and protein, vitamin and fiber content.

The estrogenic activity of legume, grass and corn silage was studied by Pieterse and Andrews (1956b). The estrogenic content of alfalfa silage was significantly greater than that of freshly cut alfalfa. No significant estrogenic activity could be found in corn or brome silages. A mixture of alfalfa, ladino clover and brome grass silage increased in estrogenic activity during fermentation. If the estrogenic activity of alfalfa or other forages is increased after ensiling, it seemed logical to these authors to assume either that an estrogen, or estrogens, present at the time of harvesting becomes more potent or that a new estrogenic substance is produced during fermentation.

In another study by Pieterse and Andrews (1956a) they compared the estrogenic activity of alfalfa at different stages of

maturity in four cuttings during the spring and summer of 1954. The spring growth or first cutting of alfalfa showed that there was considerable fluctuation in activity at different stages of maturity. In the early budding stage there was a highly significant increase in estrogen, followed by a decline until one-fourth bloom. The estrogenic activity then remained relatively high throughout the bloom and seed head stages. The pattern of estrogenic activity in relation to stage of maturity during the second, third and fourth cuttings was considerably different than during the spring growth. In the second cutting, activity remained low during the dough stage and in the third and fourth cuttings had more estrogenic activity than did any of the other three cuttings. Alfalfa leaves were more active than the flowers, and the stems had the least activity. These Purdue workers found significant estrogenic activity in ladino clover, red clover, birdfoot trefoil, wheat, rye and oats. No detectable estrogenic activity could be found in samples of sweet clover, soybean plant, brome grass, fescue and orchard grass. Fish solubles, fish meal and dried distillers' solubles were not found to be estrogenic. Soybean oil meal and moldy corn did contain detectable estrogens. They concluded that there is considerable variation in estrogenic activity between and within plant species and that differences in season, stage of growth and other environmental factors may affect hormonal activity.

Cattle Feeding Studies

Pasture Studies. Thomas, et al. (1956) studied the effect

of feeding stilbestrol during winter grazing on the range upon subsequent summer gains of steers. It was noted that the steers fed stilbestrol continuously through both the summer and winter phases and for the summer phase only made significantly greater gains for the total period than did the control steers. Gain differences between steers fed stilbestrol continuously as opposed to winter feeding only were non-significant, thus indicating some carry over effect.

At the University of Georgia, steers averaging 475 pounds were implanted with 24 mg. of stilbestrol per animal by O'Mary, et al. (1956b) and O'Mary and Cullison (1956). These steers were then put on pasture. The stilbestrol treated steers averaged 0.26 pounds greater daily gain than the controls which was significant. On the other hand, Richardson, et al. (1956a) found that a decrease in rate of gain on grass was obtained with animals that received stilbestrol in the wintering ration but did not receive stilbestrol on grass. This indicated that there was no beneficial carry over effect from feeding stilbestrol during the winter for animals that are going to pasture.

High Roughage Rations. Stitt (1956) conducted tests at Kansas State College with steer calves fed individually on a high roughage ration. One lot served as the control group, a second lot was implanted with 36 mg. of stilbestrol at the base of the ear, and a third lot received 5 mg. of stilbestrol orally per day. The implanted steers gained 0.13 pound more per head than did the control animals. Feed consumption and efficiency were increased slightly in the implanted cattle. There was little

difference in gain, feed consumption and feed efficiency between the control lot and the cattle receiving stilbestrol orally.

In a similar experiment with heifer calves on a high roughage ration, spaying and stilbestrol treatment was studied by Stitt (1956). One lot of heifers was spayed but received no stilbestrol, a second lot was spayed and fed 5 mg. of stilbestrol for the first 56 days of the test and 10 mg. per day thereafter. A third lot served as the control animals and a fourth lot was non-spayed heifers fed 5 mg. of stilbestrol per day per head the first 56 days and 10 mg. per head daily the remainder of the period. This study indicated that spaying heifers depressed the rate of growth and feed efficiency. The non-spayed heifers made their greatest increase in gain over the spayed heifers during the latter part of the feeding period. Spayed heifers fed stilbestrol showed an increase in rate of gain and feed efficiency. However, the spayed heifers with stilbestrol incorporated in their ration did not gain as rapidly or efficiently as the non-spayed (control) heifers. Stilbestrol fed to intact heifers produced no additional gain or feed efficiency. Stitt concluded from this work that there was little advantage in using stilbestrol orally or by implantation in calves on a high roughage ration.

Stilbestrol Implanted Cattle on a Fattening Ration. O'Mary et al. (1956a) when studying the effect of various levels of implantation of stilbestrol in steers on a fattening ration, noticed that the steers implanted with 36 mg. of stilbestrol had a higher rate of gain than did the control steers during the first eight weeks of the test. Steers implanted with 12 mg. of stilbestrol had no increase in rate of gain over the control animals

during this same period. During the next eight week period, an additional 24 mg. was implanted following the initial 12 mg. of stilbestrol. This resulted in a marked increase in rate of gain over the control steers the following eight weeks. At the end of the 140 day fattening period, there was a highly significant difference in rate of gain between the steers implanted with 36 mg. of stilbestrol and the control cattle, but there was no significant difference between the control steers and those implanted initially with 12 mg. and 24 mg. later. The side effect observed was a depression of the loin around 75 days after implantation.

Andrews, et al. (1950) implanted yearling steers at 60 mg. and 120 mg. levels of stilbestrol during a fattening period and found only a slight increase in rate of gain in these steers over the control animals. The implanted steers did show a slight increase in feed efficiency. The carcass grades of the treated steers and control animals were almost the same. However, Deans, et al. (1956) found that the rate of gain of the implanted cattle was no higher than that of the control steers but the implanted cattle had a healthier appetite than the controls. According to Beeson, et al. (1956), feed efficiency of steer calves on a basal ration of corn and cob meal, Purdue Supplement A, corn silage and minerals and a 36 mg. stilbestrol implant was improved 10 per cent. When stilbestrol was administered orally at 10 mg. per head per day, feed efficiency was increased 8.4 per cent.

Heifers implanted with 42 mg. of stilbestrol in the shoulder region had a higher rate of gain than did the control cattle which received no hormone according to Dinusson, et al. (1950). Clegg,

et al. (1951) implanted heifers with 5 pellets of 12 mg. each, a total of 60 mg. of stilbestrol, and noticed that the carcass grades for the treated animals were lower than the controls.

In a comparison of oral administration and implantation of stilbestrol with yearling steers, Good (1956) did not find any significant differences between the two types of treatment. He pointed out that both of the hormone treatments did show an advantage over the controls. Good also observed that stilbestrol administered either by ingestion or implantation did not significantly affect dressing percentage, shrink to market, carcass grade, cooler shrink, moisture content of fat and lean and cooking quality. The implanted hormone did significantly increase the nitrogen content of the eye muscle.

Neuman, et al. (1956) found that the oral administration of stilbestrol in combination with an implant in beef heifers gave a significant increase in gain. He further observed that intermittent implantation significantly improved gains over the controls as compared with no response to single implants. The combination of intermittent implantation and the oral administration of the hormone caused serious physiological disturbances such as prolapsed uteri, extremely elevated tailheads, excessive mammary development and depressed loins. When either of these treatments was used alone, less severe side effects were noted.

Steers that either received stilbestrol orally or by implantation had an increase in diameter of the prostatic portion of the urogenital tract, an increase in the size of the bulbo-urethral glands and seminal vesicles and indicated physiological activity

due to the hormone treatments according to Deans, et al. (1956). In a similar experiment, Good (1956) observed an increase in length of teat and an increase of the diameter and length of the penis. He also noted that the bulbo-cavernosus and retractor penis muscles were also enlarged as a result of hormone treatment.

Some of the side effects that Dinusson, et al. (1950) observed in heifers implanted with 42 mg. of stilbestrol were extreme hyperemia and swelling of the external genitalia within a week after injection of the hormone. The estrus cycle lasted 10 to 14 days. During the feeding period, the hormone treated heifers developed a nymphomaniac stance, that is they stood with tailheads elevated. Ninety days after the treatment, the heifers' teat and udder development was comparable to that seen in late gestation of beef heifers. The work of Clegg, et al. (1951) agreed with that of Dinusson. It was also observed by Clegg that heifers receiving implanted stilbestrol at a level of 60 mg. had a greater increase in the weight of the pituitaries and adrenals than did those in the control cattle at the end of the experiment. There was only a slight difference in weight of the thyroid and ovaries.

Cahill, et al. (1956) implanted a group of steers and bulls with 84 mg. of stilbestrol at the beginning of the experiment and again 85 days later. The pituitary glands and the adrenal glands were significantly heavier in weight than the same glands of the untreated animals. The thyroid glands of the implanted bulls were significantly lighter in weight than those of the untreated bulls, but treatment of the steers had little effect on the weight of this gland.

Many livestock producers have noticed that the supplementation of stilbestrol to beef cattle rations has lowered carcass grades in a number of cases. It was pointed out by Clegg, et al. (1951) that the carcass grades of heifers implanted with stilbestrol at the 60 mg. level were lower than those of the control lot. For steers, however, Andrews, et al. (1950), Deans, et al. (1956) and Good (1956) found very little difference in the carcass grade of animals implanted at either the 60 or 120 mg. level as compared to control animals. Steers implanted with 84 mg. of stilbestrol at the beginning of an experiment by Cahill, et al. (1956) and 84 days later, had lower carcass grades than the untreated animals. However, bulls receiving the same treatment had higher carcass grades than the controls. They also noted that the implanted bulls had an increase in the percentage of fat while the reverse appeared to be true in the case of the steers.

A study by Clegg and Carroll, (1956) revealed that steers and heifers implanted with stilbestrol on a fattening ration showed a decrease in fat deposition and an increase in protein anabolism over control animals. The carcass grades were somewhat lowered in the treated heifers but not in the case of the treated steers. The spaying of heifers that received no stilbestrol had no effect on the carcass grades of the heifers.

Three graders, when grading stilbestrol implanted heifers on hoof, consistently overestimated live grades as compared to the actual dressed carcass grades, according to Neuman, et al. (1956).

Many workers have noted an increase in the size of various parts of the carcass due to the growth stimulating hormone, stilbestrol. Dinusson, et al. (1950) observed that heifers implanted with stilbestrol had an increase in length of leg, length of back and width of back greater than that in the control females. Steers implanted with stilbestrol by Good (1956) had an increase in the width of the round which was the only carcass measurement that was affected by the hormone treatment. The stilbestrol treatment of the steers by Good did not significantly affect dressing percentage, shrink to market, cooler shrink, moisture content of fat and lean, and cooking quality. According to Clegg and Carroll (1956), when steers and heifers received the same hormone treatment, the bones were not affected nor the percentage of moisture in the steers, but the treatment did cause a significant increase in moisture percentage in the heifers.

Stilbestrol Orally Administered to Cattle on a Fattening Ration. Oral administration of stilbestrol to cattle on fattening rations has increased rate of gain and feed efficiency for workers such as Richardson, et al. (1956 a, b, c), Smith, et al. (1956a) and Perry, et al. (1955). When fed orally, the stilbestrol is mixed with the protein supplement. It is usually mixed at the rate of 10 mg. of stilbestrol per pound of protein supplement.

Andrews, et al. (1956b) in an experiment with steer calves on a fattening ration containing 10 mg. of stilbestrol per head per day, found that the hormone fed cattle gained significantly more than other steers fed the same level of dienestrol or hexestrol.

Richardson, et al. (1956b) found that stilbestrol administered orally at the 10 mg. level per head daily, did not produce high tailheads, weak loins, or other undesirable effects in an experiment with steers on a fattening ration. Another worker, Burroughs, et al. (1955), studied various levels of oral administration of stilbestrol and found that 5 to 10 mg. per head per day gave the best results. He also found no undesirable side effects when stilbestrol was orally administered to the cattle.

In an experiment with large steers, Richardson, et al. (1956b) found that there was no advantage in removing stilbestrol from the fattening ration after the first 56 days of feeding.

Smith, et al. (1956a) stated that the oral feeding of stilbestrol to spayed heifers was not beneficial. There was an increase in gain of only 0.17 pound per day per animal when stilbestrol was fed. This probably was due to the fact that the stilbestrol was supplying the needed estrogenic hormone to the spayed heifers that they were deprived of. The feeding of stilbestrol to intact heifers was of no benefit because of the estrogenic hormone already being produced by the ovaries.

When stilbestrol has been administered orally to cattle on fattening rations, it has caused a lowering in carcass grades according to many researchers. Richardson, et al. (1956a) stated that steers fed stilbestrol had a tendency to grade slightly lower than control animals. These lower grades were caused primarily by the lack of marbling. This effect seemed to be greatest in animals that had received stilbestrol continuously

over a long period of time. The hormone fed cattle showed slightly less rib-eye area, a slight increase in fat thickness over the 12th rib, slightly less firmness (often accompanied by greater release of fluid at cut) and a slight increase in total moisture in rib-eye and fat with a tendency toward a greater quantity of press fluid from the rib-eye. The palatability scores tended to be higher for roasts from animals fed stilbestrol. The press fluid was a lot greater from the cooked rib-eye roasts of the hormone treated cattle.

Dyer, et al. (1956) in a similar experiment with steers, noted that the cattle treated with stilbestrol had slightly higher carcass grades because of greater marbling. They found a slightly larger rib-eye area, but little difference in the amount of subcutaneous fat and other carcass measurements. The hormone treated cattle differed only slightly in aroma, flavor and juiciness from the controls, but were more tender as determined by a taste panel.

Data compiled by Kastelic, et al. (1956) from 92 beef cattle fed stilbestrol failed to provide evidence that the feeding of the hormone had any consistent influence on carcass characteristics as measured by carcass weight, grade, fat, lean and bone content of the 9th-10th-11th rib cut, the area of the cross section of the longissimus dorsi muscle and thickness of fat over the rib-eye muscle.

In a study of the effect of stilbestrol-oxytetracycline (terramycin) combination fed to steers fattened on corn silage, Smith, et al. (1956b) found that fat deposition and carcass grade seemed to be improved in the treated cattle. Carcass data

indicated that cattle fed stilbestrol alone, shrank more in shipment and had a lower dressing percentage than the control or the oxytetracycline-stilbestrol animals.

Estrogenic Residue in Meat From Cattle Fed Stilbestrol

Before the use of natural or synthetic estrogens, either as subcutaneous implants or as oral administrations as an integral part of the feed, could be recommended for general use in livestock feeds, it was necessary from a public health viewpoint to examine the edible and inedible tissues very closely for possible estrogenic residue. Estrogenic residue is important from the standpoint of domestic health and the fur industry since some of the inedible tissues are utilized in the rations of fur animals.

Some workers have pointed out that the retention of estrogens in tissues of hormone treated cattle has shown that the degree of residual activity may differ depending on the dose level, route of administration and type of tissue studied.

Stob, et al. (1956) in a study of various estrogenic hormones, found traces of estrogenic residues in the muscle, kidney, kidney fat, intestine and liver of cattle fed stilbestrol. In cattle receiving an oral treatment of dienestrol, residual estrogenic activity was found in the kidney, kidney fat, intestine and liver, while the oral administration of hexestrol to another group of cattle showed a retention of the estrogen in the kidney and kidney fat of these animals. The use of chlortetracycline in combination with hexestrol fed to cattle had no apparent effect on the residual estrogenic activity.

Turner (1956) assayed the edible portion of the carcass of steers fed 10 mg. per day per head of stilbestrol for a period of 148 days and withdrawn 44 hours before slaughter. Ovariectomized mice were used in the assay work. He concluded that the edible red meat, rib eye, neck trimmings and tongue from the hormone treated cattle did not contain detectable residual hormone. However, detectable amounts of the hormone were found in the liver, heart, spleen and brain. Evidence of estrogen was found in the kidney to the extent of four parts per billion while the lungs showed the presence of 10 to 12 parts per million of residual estrogen.

The use of synthetic estrogens would be of no value if there were sufficient amounts of the hormone retained in the edible portion of the carcass of treated animals so as to be a hazard to humans ingesting the meat of these animals.

The most common means by which man is exposed to the meat of hormone treated animals is through the ingestion of cooked meat. For this reason Stob, et al. (1954) cooked meat known to have residual hormone activity and meat to which known amounts of a hormone was added. This meat was cooked in 1000 gram meat loaves in an oven at 120° to 150°C. for two hours. The cooked meat was then fed to test animals without a grain diluent for the usual 10-day period. This study showed that cooking at this temperature had no effect on the estrogen activity. This was explained by the fact that stilbestrol is very heat stable and has a melting point of 167° to 168°C. A loss of activity might

have occurred in the tissue juices and rendered fat which were discarded in this case.

There was no demonstrable effect of the site of hormone implantation on the amount of hormone retained in the edible tissue. It can be generally stated that the greater the amount of hormone used in treating the animal, the greater the amount retained in the tissues, Stob, et al. (1954) concluded.

The human tolerance of stilbestrol appears to be extremely high. Ferguson (1953) reported that in a treatment of 190 pregnant women with a total doseage of 11,725.7 mg. of hormone from the 10th to 30th week of pregnancy, no harmful effects on fetal weight or survival or toxicity to the mother occurred. According to this data, as much as 137.5 milligrams of the hormone was taken per day during the 30th week. A person would have to consume 3,028 pounds of meat containing 0.1 micrograms of hormone per gram of cooked meat to receive an equivalent amount.

Stob, et al. (1954) concluded that in all probability the amount of hormone present in beef muscle and liver does not exceed 0.01 microgram per gram of dried tissue and 0.1 microgram per gram of dried tissue in the case of sheep muscle and chicken meat.

Lamb Feeding Studies

Stilbestrol Implanted in Lambs on a Fattening Ration. Some workers, Bell and Erhart (1956), Jordan, et al. (1955) and Andrews, et al. (1956a) found that the subcutaneous implantation of stilbestrol pellets in feeder lambs increased the rate of gain and efficiency of feed utilization. These workers noted a

reduction in carcass quality when the hormone was administered. Experimental records show that 12 mg. of stilbestrol has been the usual dosage for lambs on a fattening ration. Means, et al. (1953) implanted lambs with 12 and 24 mg. of stilbestrol. Both levels of treatment showed an increase in rate of gain and significantly increased the feed efficiency. Rate of gain was increased when fat lambs on a fattening ration received a subcutaneous implant of a 15 mg. pellet of stilbestrol, at the beginning of the feeding period, according to Bell, et al. (1954), but the administration of another implant 70 days later did not increase rate of gain. In an experiment at Kansas State College, Smith, et al. (1955) found no increase in average daily gain of lambs implanted with a 6 mg. pellet of stilbestrol. Jordan (1950) compared a 6 mg. and a 12 mg. implantation of stilbestrol in lambs on a fattening ration and noted that the lambs receiving the 6 mg. pellet did as well in rate of gain and feed efficiency as the lambs that received the 12 mg. pellet. However, the treated lambs had lower carcass grades. Jordan and Dinusson (1951) found no advantage in implantation at a level of 12 mg. of stilbestrol in suckling lambs ranging in age from one to two months, as the inherent capacity to grow is very high at this age and cannot be accelerated by this treatment.

Because of the possibility that the hormone may remain in the edible carcass as residue, it is desirable that an implantation site be used that will not remain as a part of the edible carcass. Implantation of stilbestrol in the neck, scrotum, or beneath the eye produced no significant difference in response

of lambs in either rate of gain or feed efficiency according to Andrews and Beeson (1953). The scrotum proved to be an ideal site for implantation in wether lambs since this part of the lamb is always discarded at the time of slaughter. However, it required more time to implant the scrotum than it did the eye or neck region.

A number of workers have stated that the implantation of stilbestrol in lambs on a fattening ration lowers the carcass grade. However, this statement is not in total agreement with all workers.

Lambs implanted with 6 mg. of stilbestrol at the beginning of the feeding period graded higher than did the controls according to Mackintosh, et al. (1956). The fat over the 12th rib was definitely thicker in the case of the implants, thinner in control lambs and thinnest in the orally fed stilbestrol animals. Data from cooking and palatability tests indicated little difference in the quality of the meat on leg of lamb from animals fed a control ration, a control ration plus stilbestrol and animals implanted with the hormone. Roasts from animals fed stilbestrol rated slightly more tender as measured by both judges' scores and shear force values and yielded a little more press fluid than roasts from untreated animals.

Lambs implanted with 6 mg. of stilbestrol at the beginning of the feeding period and control animals graded choice but those receiving the hormone orally at 2 mg. per head per day were one-half grade lower according to Smith, et al. (1955) and Hale, et al. (1955). Andrews, et al. (1956a) implanted 12 mg. of stilbestrol

in lambs on a fattening ration and noted that the hormone treated lambs produced lower carcass grades than did the control lambs. Jordan, (1950) stated there was no big difference in the carcass grades between lambs implanted with stilbestrol and control lambs four months of age, but the treated lambs seven months of age were of lower carcass grades than the controls. Bell, et al. (1953) described the carcasses of lambs that had received stilbestrol implants as watery and slimy in appearance.

Lambs implanted with 12 and 24 mg. of stilbestrol in two separate lots had lower carcass grades and less carcass finish than the controls according to O'Mary, et al. (1951). Lambs on both treatments also had a lower dressing percentage.

Bell, et al. (1954) implanted a 15 mg. pellet of stilbestrol in fattening lambs at the beginning of a feeding period and another 15 mg. pellet 70 days later. The dressing percentage was lower in the treated group. In another study, Bell, et al. (1953) noted that lambs receiving stilbestrol implants were more difficult to butcher because the pelts adhered so tightly to the carcass. The treated lambs shrank more in the cooler and had lower dressing percentages than did the control animals. Twelve lambs implanted with two 15-mg. pellets of stilbestrol were lost from prolapse of the rectum, excessive swelling and inflammation in the rectal or perineal region, or conditions similar to those produced by urinary calculi, in an experiment by Bell, et al. (1954). A number of the treated lambs had preputial swelling in the perineal region. Measurement of the uro-genital systems of the treated lambs showed enlarged seminal vesicles, bladder,

ampullae, urethra, prostate gland and bulbo-urethral glands. The greatest changes were found in the Cowper's gland where, in severe cases, a cul-de-sac filled with urine.

A study of the lumen of the urethra by Bell, et al. (1953) in a similar project revealed a fairly large and unimpaired opening in lambs receiving one implant, and an almost closed lumen in lambs receiving two implants. The treated lambs did not show any visible external symptoms of distress. The authors felt that further closure of the urinary passage might result in symptoms similar to that produced by a blockage of the passage by urinary calculi. The extreme swelling of the Cowper's glands may be responsible for the difficulty in passage of fecal material and could possibly result in considerable straining with resulting prolapse of the rectum.

Stilbestrol Orally Administered to Lambs on a Fattening Ration. Less work has been done on the oral administration of stilbestrol and other hormones in lamb feeding than with beef cattle.

Lambs that received stilbestrol orally were more aggressive and active at the feed bunk than the control lambs, according to Light, et al. (1956). Two protein supplements, soybean oil meal and urea, were used in the experiment. The feeding of stilbestrol produced significantly greater gains on both types of nitrogen. The response in gain was greatest at the 0.5 mg. level and smallest between the 1.0 and 2.0 mg. levels. The response of the lambs to the hormone was not affected by their sex. There was no difference in carcass grades and yields between the treated and

untreated lambs. No death loss nor observable deleterious effects were attributed to the oral administration of the hormone.

Feeding stilbestrol at 0.1 mg., 0.5 mg or 1.5 mg. per lamb daily did not significantly increase rate of gain in studies by Jordan, et al. (1955). The lambs that received stilbestrol at the 0.1 mg. and 0.5 mg. levels produced higher grading carcasses than did the controls. The lambs on the 1.5 mg. level of the hormone produced carcasses of a quality comparable to the controls. The carcass yield, based on selling weights of the live lambs and warm carcass weights, was lower in all stilbestrol fed lots.

Two mg. of stilbestrol that was fed to feeder lambs daily by Smith, et al. (1955) produced carcasses one-half grade lower than the control animal carcasses. Measurements indicated that the hormone treatment increased the size of the accessory reproductive glands and bladders.

Mackintosh, et al. (1956) observed that lambs receiving stilbestrol orally at the rate of 2 mg. daily had a significant increase in liver weight. The lambs also had a heavier pelt than did the controls and the carcass grades were significantly lower than the control animals. The fat over the 12th rib was definitely thicker in the case of the lambs implanted with 6 mg. of stilbestrol and thinnest in the lambs fed stilbestrol. Data from cooking and palatability tests indicated little difference in the quality of the meat on legs of lamb from lambs fed a control ration plus stilbestrol. Roasts from animals fed stilbestrol rated slightly more tender, as measured by both judges scores and

shear force values and yielded a little more press fluid than roasts from the other lots.

Hale, et al. (1955) reported that wethers fed 2 mg. of stilbestrol daily on a fattening ration showed an increased rate of gain which was approximately 22 percent greater than the control lambs. No consistent increase in feed consumption was noted in stilbestrol-fed lambs at the 2 mg. level. The hormone, at the 2 mg. level, had little or no effect upon carcass quality; however, at higher levels there was an apparent decrease in carcass quality. When lambs were fed 3.6 mg. of stilbestrol per lamb daily, the hormone failed to promote as satisfactory rates of gain as it did at the lower levels. Close examination of the orally treated lambs revealed changes in external appearance which were similar to those noted in implanted lambs. The changes observed were enlargement of the prepuce, mammary development and edema of the anal area. The degree of these conditions appeared to be associated with the level of stilbestrol fed.

Digestion and Metabolism Studies

In a digestion trial by Richardson, et al. (1955) using 11 Hereford yearling steers that were fed a ration of one part alfalfa hay to three parts of grain and 10 mg. of stilbestrol per head daily, there was a consistent lowering of digestibility when stilbestrol was added to the ration. The average percent apparent digestibility was lower for crude protein, ether extract, crude fiber, nitrogen-free extract, and percent of total digestible nutrients in the treated animals.

When yearling steers were fed a high and low roughage ration by Erwin, et al. (1956) the addition of stilbestrol at 0.45 mg. per pound of feed did not significantly influence the digestibility of either the dry matter, crude fiber, ether extract or crude protein in the ration. A higher digestibility of dry matter occurred in lots fed the alfalfa rations than in those fed wheat straw. The digestibility of ether extract was higher in steers fed straw than in steers fed the alfalfa ration.

Twelve mg. of stilbestrol was implanted in the ears of two-year old Hereford steers which were maintained on a fattening ration for a period of 150 days by Clegg and Carroll (1956). Data from this study indicated that the stilbestrol treatment resulted in decreased fat deposition and an increased protein anabolism. The stilbestrol implantation did not affect serum protein-bound iodine, potassium and sodium.

Story, et al. (1955) found that when lambs received 2 mg. of stilbestrol in the daily ration, approximately 50 percent of the daily intake of stilbestrol was excreted in the feces and 10 percent in the urine. With the addition of 0, 2 and 4 mg. of stilbestrol to the ration in successive metabolism trials, digestibility of the dry matter was 69.8, 73.5 and 77.7 percent, respectively. A part of the increase in digestibility of the dry matter was accounted for by increased digestibility of the nitrogen fraction. The nitrogen retention in these lambs increased with the increasing levels of stilbestrol intake.

Estrogens were found by Stob (1956) in the feces of sheep treated with stilbestrol subcutaneously and dienestrol orally as

well as in the feces of cattle treated orally with stilbestrol, dienestrol and hexestrol. It was demonstrated that the main pathway of absorption of oral estrogens in rats is the portal systems and that more than 50 percent of the administered radio-active labelled stilbestrol was present in the feces. In this study estrogenic activity could be found in feces of stilbestrol treated sheep when they were implanted subcutaneously. The author explained the presence of estrogenic activity in the feces from the assumption that a subcutaneously administered hormone does not necessarily pass through the liver on its way to the feces whereas an orally administered hormone does.

A study by Bell, et al. (1955) indicated that the oral administration of stilbestrol to lambs increases the retention of calcium, phosphorous and nitrogen in the lambs.

Struempler and Burroughs (1956) noted that nitrogen retention was increased significantly by stilbestrol feeding in the higher protein rations of 14 and 20 percent, the increase being of about the same magnitude on a lamb-day basis. With the feeding of a lower protein ration of 8 percent, the increased nitrogen retention was slight or failed to occur. Altering the amino-acid contents of the ration also failed to influence nitrogen retention. No significant difference was noted between additions of either 1.2 or 2.4 mg. per lamb daily. Dry matter and protein digestibility were not affected by stilbestrol administration irrespective of its influence or lack of influence upon nitrogen retention.

It was found by Welch, et al. (1956) that stilbestrol did

not influence organic matter or protein digestibility but did significantly improve nitrogen retention.

Whitehair, et al. (1953) implanted one lot of lambs with 24 mg. of stilbestrol and did not notice any apparent effect on the digestibility of major nutrients in the ration other than a slight increase in digestibility of the crude fiber. The retention of calcium, phosphorous and nitrogen in the hormone treated lambs showed a marked increase.

Nitrogen retention was almost doubled in steers following stilbestrol administration, according to Clegg and Cole (1954). Digestibility of the ration was lowered by oral administration of stilbestrol in lamb digestion studies, according to Germann (1957). Nitrogen retention may possibly be increased, but results of the nitrogen balance studies indicate that the amount is small.

Mode of Action of Stilbestrol

The mode of action of hormones in feed efficiency and rate of gain is not completely understood. Clegg and Cole (1954) observed that nitrogen retention was almost doubled when stilbestrol was implanted in steers. Other investigators, Whitehair, et al. (1953) and Bell, et al. (1955) found similar results with nitrogen retention and also noticed a marked increase in the retention of calcium and phosphorous.

Clegg and Cole (1954) noticed that the administration of stilbestrol to ruminants resulted in hypertrophy of the pituitary glands, increased secretion of ACTH by a depression of blood,

eosinophils in lambs and hypertrophy of the adrenal glands in both cattle and sheep. The author explained that androgens are responsible for the growth effect.

There was a greater water content in treated lambs and it was suggested by O'Mary, et al. (1952) that this might account for some of the increase in rate of gain in weight.

It was observed by Clegg and Carroll (1956) that there was no difference in bone or percent moisture between treated and untreated steers. This indicated that the increased gains following treatment were not due to an effect upon bone development nor could the additional weight be accounted for on the basis of increased water content of the tissues. In younger animals, however, moisture content was significantly increased and there was a suggestion of a greater percentage of bone because of the treatment.

The results of physical and chemical analysis of the 12th rib region indicated differences in carcass composition as a result of the stilbestrol treatment. The data indicated that the hormone treatment resulted in a decreased fat deposition and an increased protein anabolism.

EXPERIMENTAL

Method of Procedure

This experiment was conducted to obtain information on (1) the value of stilbestrol in the wintering ration of beef calves, (2) the carryover effect during grazing and fattening,

(3) the value of stilbestrol in both the wintering and fattening ration of beef calves, (4) the effect of stilbestrol on feed utilization, and (5) the effect of stilbestrol on carcass grade.

Twenty-seven head of good quality Hereford steer calves averaging 400 pounds at the beginning of the experiment were divided into three lots (Lot numbers 1, 2 and 3) of nine animals each on the basis of weight and quality. One group, Lot 1, received five mg. of stilbestrol orally per head per day mixed in soybean oil meal the first 56 days of the wintering phase and 10 mg. per head per day the remainder of the phase. Lots 2 and 3 did not receive stilbestrol during the wintering phase. Because of lack of pen room, lots 2 and 3 were wintered in the same pen. The steers were on a wintering ration from December 1, 1955 to May 16, 1956, a period of 168 days. All lots were fed a basal ration of 1.00 pound of soybean oil meal, 4.00 pounds of ground milo and 27.31 pounds of Atlas sorghum silage per head daily. A mineral mixture of one part steamed bone meal and one part salt was fed free choice. Fresh water in stock tanks was available at all times. The animals were weighed each 28 days.

All 27 steers were grazed on good bluestem pasture from May 17, 1956 to August 17, 1956, a period of 92 days. No stilbestrol was fed to any of the lots during the grazing phase. The animals were weighed at the beginning and end of the grazing phase. One steer in lot 2 became infected with pink eye and was brought back to the barn for treatment. He started with the other animals on the fattening phase.

Lots 1 and 2 were fed 10 mg. per head per day of stilbestrol mixed in soybean oil meal during the fattening phase. Lot 3 was the control lot. The steers were on a fattening ration from August 17, 1956 to January 7, 1957, a period of 142 days. All three lots were fed a basal ration of 1.00 pound of soybean oil meal per head daily, ground milo grain and prairie hay ad libitum and free access to a mineral mixture of one part steamed bonemeal and one part salt. It took from August 17, 1956 to September 18, 1956, a period of 32 days, to put the steers on full feed of ground milo. A steer in lot 3 developed lump jaw, however, he was treated and remained in the lot throughout the test. The steers were weighed at 28 day intervals and twice at the end of the experiment. They were graded on foot by an appraisal committee six days before slaughter at the Swift Packing Plant in Kansas City, Missouri, on January 9, 1957. Dressed carcass weight, carcass grade before and after ribbing, fat thickness, degree of marbling, size of rib-eye, degree of firmness and distribution of fat was obtained on each individual animal.

Results of the Wintering Phase

The calves were started on test December 1, 1955, and were continued on the wintering phase until May 16, 1956. Results of the wintering phase of the study are presented in Table 1. The treated steers in lot 1 gained an average of 42 pounds more than did lot 2 and an average of 51 pounds more than lot 3 during the wintering phase. The stilbestrol fed steers gained 1.80 pounds per day per head in comparison with 1.55 pounds per head per day

for lot 2 and 1.50 pounds per head per day for lot 3. The final weight for the wintering phase was taken on May 16, 1956.

The treated steers in lot 1 made an average daily gain of 0.30 pounds per steer per day greater than the control steers. The average daily gain per steer was about the same for the two control lots 2 and 3. The stilbestrol fed steers were slightly more efficient in converting feed to gain. It took 31 pounds less of ground milo and 282 pounds less of sorghum silage per 100 pounds of gain for the stilbestrol fed animals. Feed consumption in the three lots was very nearly the same.

Table 1. Results of the wintering phase with and without stilbestrol in the ration.

Lot	1*	2	3
Number steer calves per lot	9	9	9
Number days on feed	168	168	168
Av. initial wt. lbs.	397	402	397
Av. final wt. lbs.	701	663	650
Av. total gain lbs.	304	262	253
Av. daily gain lbs.	1.80	1.55	1.50
Av. daily ration lbs.			
Soybean oil meal	1.00	1.00	1.00
Ground milo grain	4.00	4.00	4.00
Atlas sorghum silage	27.55	27.30	27.31
Mineral (½ bonemeal ½ salt)	.07	.04	.04
Salt	.07	.05	.05
Lbs. feed per 100 lbs. gain:			
Soybean oil meal	55.26	64.12	66.40
Ground milo grain	221.94	256.83	265.05
Atlas sorghum silage	1692.31	1945.95	2014.24
Mineral (½ bonemeal ½ salt)	.35	.22	.23
Salt	.36	.28	.29

* fed 5 mg. stilbestrol per head daily first 56 days of wintering ration and 10 mg. thereafter in both wintering and fattening ration.

Results of the Grazing Phase

The steers were taken to pasture on May 17, 1956. The steers in lot 1, which had received stilbestrol during the wintering phase did not receive any during the grazing phase. They gained slightly less during the grazing period than did the control steers in lots 2 and 3. The control animals in lot 3 gained an average of 27 pounds more during the same grazing period than the steers in lot 1 which received stilbestrol during the wintering phase. Lot 3 animals gained the least in the wintering phase. The steers in lot 2, gained an average of 18 pounds less during the grazing phase than did the steers in lot 3.

Table 2. Results of the grazing phase.

Lot	1*	2	3
Number steer calves per lot	9	9	9
Number days on grass	92	92	92
Av. initial wt. lbs	701	663	649
Av. final wt. lbs.	741	714	716
Av. total gain lbs.	40	49	67
Av. daily gain lbs.	0.43	0.53	0.73

* Received stilbestrol in the wintering ration but not while grazing.

The steers gained 0.43, 0.53, 0.73 pound per head daily in lots 1, 2 and 3 respectively. Low gains on grass were to be expected, however, since these calves made good gains during the wintering phase of the test.

The results of this experiment indicate that there was no beneficial carryover effect from feeding stilbestrol during the

winter to animals that are going to pasture. Data for the grazing phase is presented in Table 2.

Results of the Fattening Phase

The steers were taken off grass August 17, 1956, and put in the feed lot for fattening for 142 days. The results of the fattening phase are presented in Table 3.

Table 3. Results of the fattening phase with and without stilbestrol in the ration.

Lot	1*	2**	3
Number steer calves per lot	9	9	9
Number days on feed	142	142	142
Av. initial wt. lbs.	741	714	716
Av. final wt. lbs.	1088	1042	1032
Av. total gain lbs.	347	327.6	315.8
Av. daily gain lbs.	2.44	2.33	2.22
Av. daily ration lbs.			
Soybean oil meal	1.00	1.00	1.00
Ground milo grain	16.91	16.28	17.73
Prairie hay	5.24	5.05	4.97
Salt	.31	.31	.19
Lbs. feed per 100 lbs. gain:			
Soybean oil meal	40.92	43.33	44.95
Ground milo grain	692.22	705.90	797.04
Prairie hay	214.79	218.88	223.42
Salt	1.28	1.35	0.80

* Received 5 mg. stilbestrol per head daily first 56 days of wintering phase and 10 mg. thereafter in both wintering and fattening ration.

** Received 10 mg. stilbestrol per head daily during the fattening phase only.

The steers that received stilbestrol during both the wintering and fattening phase gained an average of 31.2 pounds more than the control steers and 19.4 pounds more than the steers that received stilbestrol during the fattening phase only. The steers

that received stilbestrol during the fattening phase only gained an average of 11.8 pounds more than the control animals.

The average daily gains were 2.44, 2.33 and 2.22 pounds per head per day in lots 1, 2 and 3 respectively during the fattening phase.

The treated steers in lot 1 that received stilbestrol during both the wintering and fattening phase consumed 104.82 pounds less ground milo per 100 pounds of gain than did the control steers in lot 3. The treated steers in lot 1 consumed 13.72 pounds less ground milo per 100 pounds of gain than did the steers in lot 2 which received stilbestrol during the fattening phase only. The treated steers in lot 2 consumed 91.14 pounds less of ground milo per 100 pounds of gain than did the steers in lot 1. The steers in lots 1 and 2 utilized their feed more efficiently than the control steers.

The rates of gain for the entire 406 day test were 1.70, 1.58 and 1.56 pounds per head daily for lots 1, 2 and 3 respectively.

Discussion of Carcass Findings

Data from the carcass findings are presented in Tables 4, 5 and 6. There was no appreciable difference in percent of shrink to market between the three lots. The steers in lot 1 lost 328 pounds, or 3.33 percent shrink, those in lot 2 lost 374 pounds or 3.98 percent shrink, and lot 3 lost 296 pounds or 3.18 percent shrink.

The dressing percentage on hot-weight carcasses was slightly in favor of the control animals in lot 3. The dressing percentage

Table 4. Summary of Carcass findings from steer calves fed rations with and without stilbestrol.

Lot	1*	2**	3
Number carcasses per lot	9	9	9
% shrink to market	3.33	3.98	3.18
Dressing % (hot wt.)	61.49	62.30	62.39
Av. carcass grade before ribbing	15.55	14.44	14.00
Av. carcass grade after ribbing[1]	14.66	14.00	12.44
Number carcasses upgraded	3	3	6
Number carcasses downgraded	1	1	1
Av. fat thickness over 12th rib[2]	3.77	3.77	3.55
Av. degree of marbling[3]	7.66	6.44	6.44
Av. size of rib-eye[4]	4.00	4.22	4.00
Av. degree of firmness[5]	4.11	4.11	3.66
Av. distribution of fat[6]	2.33	3.22	2.55
US Grades:			
Choice	1	3	5
Good	8	5	4
Standard		1	

* Received 5 mg stilbestrol per head daily first 56 days of wintering phase and 10 mg. thereafter in both wintering and fattening ration.

** Received 10 mg. stilbestrol per head daily during the fattening phase only.

1. Based on prime 4; low prime 6; top choice 8; choice 10; low choice 12; top good 14; good 16; low good 18; top standard 20.
2. Based on very thick 1; thick 2; moderate 3; modest 4.
3. Based on very abundant 1; abundant 2; moderately abundant 3; slightly abundant 4; moderate 5; modest 6; small amount 7.
4. Based on modestly large 4; slightly small 5.
5. Based on moderately firm 3; modestly firm 4; slightly firm 5.
6. Based on very uniform 1; uniform 2; moderately uniform 3.

was 61.49 percent for lot 1, 62.30 percent for lot 2 and 62.39 percent for the control lot 3.

There was no difference in the size of the rib-eye muscle between the control and treated lots, according to scores given

Table 5. Results of Appraisal committe valuation of treated and nontreated steers on hoof.

Lot No.	Steer No.	Committee Number 1	2	3	4	5	6	7	8	9	10	Av. Live Grade	USDA Grade	
1	R 2	18	14	14	12	16	16	12	16	14	16	14.8	16	G
	R20	8	10	10	10	10	12	10	8	10	12	10.00	14	G+
	R47	12	10	10	8	10	12	14	10	14	12	11.2	14	G+
	R55	6	10	10	8	8	10	12	12	8	8	9.2	12	C-
	R94	12	12	12	10	12	12	14	14	14	12	12.4	16	G
	L37	6	12	14	14	10	14	12	12	10	14	11.8	14	G+
	L76	18	14	14	14	14	16	18	14	14	18	15.4	16	G
	L99	10	14	12	12	14	16	14	16	14	16	13.8	14	G+
	RR3	12	12	14	10	12	10	14	14	12	12	12.2	16	G
	Average	11.3	11.8	12.4	10.9	11.8	13.1	13.3	12.9	12.2	13.3	12.3	14.6	
2	R 1	4	12	12	8	8	14	12	10	12	12	10.4	12	C-
	R23	18	14	16	20	20	18	18	20	14	16	17.4	20	S+
	R53	12	10	12	14	10	16	14	12	10	10	12.0	12	C-
	R93	8	10	12	14	10	18	12	14	12	10	13.0	14	G+
	L46	8	8	12	8	8	16	10	12	8	12	10.2	14	G+
	L90	14	10	14	18	18	18	18	18	12	14	15.4	14	G+
	L96	10	10	12	12	12	16	16	16	12	12	12.8	14	G+
	RR8	8	10	12	12	10	12	14	8	10	12	10.8	14	G+
	RR27	12	12	14	10	16	16	14	18	12	16	14.0	12	C-
	Average	10.6	10.6	12.9	12.6	12.4	16.0	14.2	14.2	11.3	12.6	12.8	14	
3	R38	20	12	16	14	12	14	16	16	14	14	14.8	8	C+
	R57	12	14	12	12	12	12	16	14	14	14	13.4	14	G+
	R80	14	12	14	12	10	14	16	14	12	12	14.0	16	G
	R85	14	14	14	14	10	14	16	14	12	14	13.6	14	G+
	L33	12	10	12	10	12	12	14	14	12	16	12.4	12	C-
	L51	12	10	14	14	14	14	16	14	10	10	12.8	18	G-
	L72	20	14	14	16	12	12	16	16	14	16	15.0	10	C
	L48	10	12	14	10	10	14	14	18	12	12	12.6	12	C-
	RR30	14	8	12	10	6	12	10	14	8	10	10.4	8	C+
	Average	14.2	11.7	13.5	12.5	10.9	13.1	14.9	14.9	12.0	13.3	13.1	12.4	

Table 6. Carcass findings from steer calves fed rations with and without stilbestrol.

Lot No.	Steer No.	Carcass Wt.	Grade Before-Ribbing	Grade After-Ribbing	Fat Thickness[1]	Degree Marbling[2]	Size Rib Eye[3]	Degree Firmness[4]	Distribution Fat[5]
1*	R 2	601	C-	C	5	8	4	4	4
	R20	676	C+	C+	3	8	4	4	2
	R47	631	C	C+	4	6	4	3	4
	R55	686	C+	C-	4	6	4	4	2
	R94	631	C	C	3	9	4	4	2
	L37	684	C+	C+	3	7	4	4	2
	L76	631	C	C	4	8	4	5	2
	L99	616	C	C+	4	8	4	4	3
	RR3	661	C	C	4	9	4	5	2
	Av.	646.33			3.77	7.66	4.0	4.11	2.33
2**	R 1	635	C-	C-	2	6	3	5	2
	R23	541	S+	S+	6	9	5	5	6
	R53	641	C+	C-	3	6	4	4	2
	R93	661	C+	C+	2	3	4	5	2
	L46	664	C-	C+	5	7	4	4	3
	L90	641	C+	C+	4	7	5	4	4
	L96	581	C+	C+	4	7	5	5	3
	RR8	676	C	C+	4	7	4	5	2
	RR27	567	C+	C-	4	6	4	4	5
	Av.	623.0			3.77	6.44	4.22	4.11	3.22
3	R57	612	C	C+	4	7	4	4	3
	R80	636	C	C	4	9	4	5	2
	R85	661	C+	C+	3	7	4	4	2
	L33	596	C+	C-	4	7	4	4	2
	L51	581	C	C-	5	9	5	5	3
	L72	626	C-	C	3	5	4	2	2
	L48	642	C+	C-	4	6	3	3	2
	RR30	631	C-	C+	2	4	3	2	3
	Av.	623.44			3.55	6.44	4.0	3.66	2.55

* Received 5 mg. stilbestrol per head daily first 56 days of wintering phase and 10 mg. thereafter in both wintering and fattening ration.

** Received 10 mg. stilbestrol per head daily during the fattening phase only.

1. Based on moderate 3; modest 4; slightly thin 5.
2. Based on modest 6; small amount 7; slight amount 8; traces 9.
3. Based on moderately large 3; modestly large 4; slightly small 5.
4. Based on moderately firm 3; modestly firm 4; slightly firm 5.
5. Based on uniform 2; moderately uniform 3; modestly uniform 4; slightly uneven 5; thin 6.

by the USDA meat grader. No tracings were taken of the rib-eye muscle. No observable difference could be found in fat thickness over the 12th rib.

There was a slight difference in degree of marbling in favor of carcasses from the control animals over the carcasses from the treated animals. Although the degree of firmness was nearly equal in all three lots, there was a very slight tendency for the carcasses from the control lot 3 to be firmer.

Six days before the steers were slaughtered, an appraisal committee of 10 staff members of the Animal Husbandry Department at Kansas State College put an estimate of the carcass grade on each steer on hoof. The committee graded the animals to the nearest third of a carcass grade. The following numerical value was given for each of the grades, low prime 6, top choice 8, choice 10, low choice 12, top good 14, good 16, low good 18, and top standard 20. This committee had a tendency to grade the treated steers in lots 1 and 2 slightly higher than those in lot 3 which were the control animals. This information is presented in Table 5.

The USDA meat grader graded the control carcasses in lot 3 one-third of a grade higher than the treated carcasses in lots 1 and 2. The control lot had more carcasses in the choice grade than did both of the treated lots. The control lot had five carcasses in the choice and four in the good grade. The carcasses in lot 2 from treated steers had three in the choice, five in the good and one in the standard grade. Lot 1 which received stilbestrol in the wintering and fattening phase had one in the choice and eight carcasses in the good grade.

GENERAL DISCUSSION

Steer calves that received stilbestrol orally during the wintering phase gained slightly more than steers that did not receive the hormone. The control steers consumed slightly more feed during the wintering phase. It took 31 pounds less of ground milo and 282 pounds less of sorghum silage per 100 pounds of gain for the stilbestrol fed steers than it did for the control animals. The treated steers made better utilization of feed consumed. The addition of stilbestrol to the wintering ration of steer calves was economical to feed under the conditions of this experiment, whereas Stitt (1956) concluded that there was little advantage in administrating stilbestrol orally to calves on a high roughage ration.

When the steers were taken to pasture for a period of 92 days, stilbestrol was discontinued in lot 1. They gained less than the control animals. This demonstrated that there was no carry over effect of the stilbestrol from wintering to pasturing. This supports work done by Richardson, et al. (1956a) who found that a decrease in rate of gain on grass was obtained with animals that received stilbestrol in the winter ration but not during the grazing season. However, in this experiment it was possible that the treated steers were in better condition before going to pasture.

During the fattening phase, the treated steers in both lots gained slightly more than did the control animals. Richardson, et al. (1956a, b, c), Smith, et al. (1956a) and Perry, et al.

(1955) obtained similar results on oral administration of stilbestrol to cattle on fattening rations. There was very little difference in gain between the steers receiving stilbestrol during the wintering and fattening phases and those receiving the hormone during the fattening phase only.

There was very little difference in the amount of feed consumed per 100 pounds of gain between the two treated lots of steers. There was a substantial difference in the amount of feed consumed per 100 pounds of gain between the treated steers and the control animals. It took an average of 97 pounds less of ground milo per 100 pounds of gain for each of the treated lots. The oral administration of stilbestrol to cattle on fattening rations also increased feed efficiency for Richardson, et al. (1956a, b, c), Smith, et al. (1956a) and Perry, et al. (1955).

No noticeable adverse side effects were observed during the experiment due to the feeding of stilbestrol. These results are in agreement with those obtained by Richardson, et al. (1956b) and Burroughs, et al. (1955).

The control steers had slightly less shrink to market than the steers fed stilbestrol which is in agreement with work reported by Smith, et al. (1956b).

An appraisal committee had a tendency to grade the two treated lots on hoof slightly higher than the control steers. When the carcasses were graded on the rail by a USDA grader, the control carcasses graded one-third of a grade higher than the treated carcasses. The control lot had more choice carcasses than did

both of the treated lots. Richardson, et al. (1956a) had previously found that steers fed stilbestrol had a tendency to grade slightly lower than control animals.

SUMMARY AND OBSERVATIONS

This study was conducted to obtain information on (1) the value of stilbestrol in the wintering ration of beef calves, (2) the carry over effect during grazing and fattening, (3) the value of stilbestrol in both the wintering and fattening ration of beef calves, (4) the effect of stilbestrol on feed utilization, and (5) the effect of stilbestrol on carcass grade.

Twenty-seven head of good quality Hereford steer calves averaging 400 pounds at the beginning of the test were divided into three lots of nine animals each on the basis of weight and quality. Lot 1 received 5 mg. of stilbestrol orally per head daily mixed in soybean oil meal the first 56 days of the wintering phase and 10 mg. per head daily the remainder of the wintering phase. Lots 2 and 3 served as controls during the wintering phase. All 27 steers were grazed on good bluestem pasture a period of 92 days. No stilbestrol was fed to any of the lots during the grazing phase. Lots 1 and 2 were fed 10 mg. of stilbestrol per head per day mixed in soybean oil meal during the fattening phase. Lot 3 was the control lot. The steers were graded on foot by an appraisal committee six days before they were slaughtered. Carcass data were obtained on each individual steer at the time of marketing and slaughter.

Under conditions of this study the feeding of stilbestrol to steer calves on a wintering ration was economical. This was credited to better utilization of feed by the stilbestrol fed calves.

The steers that received stilbestrol during the wintering phase and not during the grazing phase gained less during the grazing phase than did the control steers. This indicated that there was no beneficial carry over effect of the stilbestrol. This rate of gain during the grazing phase might be explained on the assumption that the treated steers were in better condition than the control steers prior to pasturing.

No noticeable adverse side effects were observed in any of the animals receiving stilbestrol.

There was very little difference between the treated and control steers in shrink to market.

An appraisal committee had a tendency to grade the treated steers slightly higher than the control steers on the hoof. However, lower carcass grades were given to the treated steer carcasses when graded by a USDA grader. The control carcasses graded one-third of a grade higher than the treated carcasses. The control lot had more carcasses that graded in the choice grade than both of the treated lots.

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LITERATURE CITED

Andrews, F. N., W. M. Beeson and F. D. Johonson.
The effect of hormones on the growth and fattening of yearling steers. J. Animal Sci. 9:677. 1950.

Andrews, F. N. and W. M. Beeson.
The effects of various methods of estrogens administration on the growth and fattening of wether lambs. J. Animal Sci. 12:182-187. 1953.

Andrews, F. N., Martin Stob, T. W. Perry and W. M. Beeson.
The effect of oral and subcutaneous estrogenic and androgen administration on growth and carcass quality of lambs. J. Animal Sci. 15:575-588. 1956 a.

Andrews, F. N., Martin Stob, T. W. Perry and W. M. Beeson.
The oral administration of diethylstilbestrol, dienestrol and hexestrol for fattening calves. J. Animal Sci. 15: 685-688. 1956 b.

Beeson, W. M., T. W. Perry, F. N. Andrews, W. H. Smith and Martin Stob.
The comparative effect of oral and subcutaneous implantation of diethylstilbestrol for fattening steers on dry lot and pasture. J. Animal Sci. 15:1240-1241. 1956.

Bell, T. Donald, Walter H. Smith and A. B. Erhart.
Supplemental report concerning the use of stilbestrol. Kansas Agr. Exp. Sta. Circ. 297:7-12. 1953.

Bell, T. Donald, Walter Smith and A. B. Erhart.
The effect of stilbestrol upon lambs performance in the feedlot. J. Animal Sci. 13:425-432. 1954.

Bell, M. C., J. R. Taylor, R. L. Murphree and C. S. Hobbs.
The effects of feeding urea and stilbestrol on ration digestibility and on calcium, phosphorous and nitrogen retention in lambs. J. Animal Sci. 14:1193-1194. 1955.

Bell, T. Donald and A. B. Erhart.
Feed lot and pasture fattening tests with feeder lambs. Kansas Agr. Exp. Sta. Circ. 335:58-63. 1956.

Bennetts, H. W., E. J. Underwood and F. L. Shier.
A specfic breeding problem of sheep on subterranean clover pastures in Western Australia. Australian Vet J. 22:2. 1946.

Burroughs, Wise, C. C. Culberson, Edumund Cheng, W. H. Hale and Paul Homeyer.
The influence of oral administration of diethylstilbestrol to beef cattle. J. Animal Sci. 14:1015-1024. 1955.

Cahill, V. R., L. E. Kunkle, Earle W. Klosterman, F. E. Deatherage and Eugen Wierbicki.
Effect of diethylstilbestrol implantation on carcass compostion and the weights of certain endocrine glands of steers and bulls. J. Animal Sci. 15:701-709. 1956.

Clegg, M. T., H. H. Cole and H. R. Guilbert.
Effects of stilbestrol on beef heifers and steers. J. Animal Sci. 10:1075. 1951.

Clegg, M. T. and H. H. Cole.
The action of stilbestrol on the growth response in ruminants. J. Animal Sci. 13:108-130. 1954.

Clegg, M. T. and F. D. Carroll.
Further studies on the anabolic effect of stilbestrol in cattle as indicated by carcass composition. J. Animals Sci. 15:37-47. 1956.

Deans, R. J., W. J. Van Arsdell, E. P. Reineke and J. J. Bratzler.
The effect of progesterone-estradiol implants and stilbestrol feeding on feed lot performance and carcass charactertistics of steers. J. Animal Sci. 15:1020-1028. 1956.

Dinusson, W. E., F. N. Andrews and W. M. Beeson.
The effects of stilbestrol, testosterone, thyroid alternation and spaying on the growth and fattening of beef heifers. J. Animal Sci. 9:312-329. 1950.

Dyer, A. J., W. H. Pfander, D. E. Brady and C. W. Turner.
Effects of adding hexestrol and rumen organisms to a cattle fattening ration. J. Animal Sci. 15:1291. 1956.

Erwin, E. S., I. A. Dyer and M. E. Ensminger.
Digestibility of dry matter, crude fiber, protein and ether extract. J. Animal Sci. 15:717-721. 1956.

Ferguson, J. H.
Effect of stilbestrol on pregnancy compared to the effect of a placebo. Amer. Jour. Obs. and Gyn. 65:592. 1953.

Good, Don LaDoyt.
The effects of diethylstilbestrol administered by implantation and ingestion on growth fattening and carcass characteristics of beef steers. Ph. D. Thesis. University of Minn. 1956.

Germann, Ralph Neil.
The use of diethylstilbestrol in ruminant rations. Master's Thesis Kansas State College. 1957.

Hale, W. H., P. G. Homeyer, C. C. Culberston and Wise Burroughs.
Response of lambs fed varied levels of diethylstilbestrol. J. Animal Sci. 14:909-918. 1955.

Jordan, R. M.
The effect of stilbestrol on fattening lambs. J. Animal Sci. 9:383-386. 1950.

Jordan, R. M. and W. E. Dinusson.
Effect of stilbestrol on the growth rate on suckling lambs. J. Animal Sci. 9:38-41. 1951.

Jordan, P.S., R. M. Jordan and H. G. Croom.
Effect of stilbestrol, progesterone-estradiol implants and oral administration of stilbestrol on fattening lambs. J. Animal Sci. 14:936-940. 1955.

Jordan, R. M. and H. G. Croom.
The effect of various hormone implants on fattening lambs. J. Animal Sci. 15:1003-1007. 1956.

Kastelic, Joe, Paul Homeyer and E. A. Kline.
The influence of the oral administration of diethylstilbestrol on certain carcass characteristics of beef cattle. J. Animal Sci. 15:689-700. 1956.

Light, Merle R., W. E. Dinusson, R. M. Richard and D. W. Bolin.
Urea and stilbestrol for fattening lambs. J. Animal Sci. 15:570-574. 1956.

Mackintosh, David D., Ralph P. Soule Jr., T.D. Bell, J. J. Hall, Dorothy Harrison and Beulah Westerman.
The effects of implanting stilbestrol in feeder lambs and feeding a stilbestrol premix to feeder lambs upon the quality and palatability of the carcass. Kansas Agr. Exp. Sta. Circular 335:68-69. 1956.

Means, T. M., F. N. Andrews and W. M. Beeson.
The effects of hormones on the growth and fattening of lambs. J. Animal Sci. 12:176-181. 1953.

Neuman, A. L., W. W. Albert and B. C. Breidenstein.
A study of time and method of hormone administration for beef heifers. J. Animal Sci. 15:1285-1286. 1956.

O'Mary, C. C., A. L. Pope, G. G. Wilson, R. W. Bray and L. W. Casida.
The effects of diethylstilbestrol, testosterone and progesterone on growth and fattening and on certain carcass characteristics of western lambs. J. Animal Sci. 10:1079-1080. 1951.

O'Mary, C. C., A. L. Pope, G.G. Wilson, R.W. Bray and L.W. Casida.
The effects of diethylstilbestrol, testosterone and progesterone on growth and fattening and certain carcass characteristics of western lambs. J. Animal Sci. 11:656-673. 1952.

O'Mary, C. C. and A. E. Cullison.
Effects of low level of implantation of stilbestrol in steers on pasture. J. Animal Sci. 15:48-51. 1956.

O'Mary, C. C., E. P. Warren, T. J. Davis and H. H. Pierce Jr.
Effects of low levels implantation of stilbestrol in steers fattened on dry lot rations. J. Animal Sci. 15:52-58. 1956 a.

O'Mary, C. C., J. L. Carmon and A. E. Cullison.
Effect of stilbestrol implanted in cattle on pasture.
J. Animal Sci. 1:1277. 1956. b.

Perry, T. W., W. M. Beeson, F. N. Andrews and Martin Stob.
The effect of oral administration of hormones on growth rate and deposition in the carcass of fattening steers.
J. Animal Sci. 14:329-335. 1955.

Pieterse, P. J. S. and F. N. Andrews.
The estrogenic activity of alfalfa and other feedstuffs.
J. Animal Sci. 15:25-36. 1956. a.

Pieterse, P. J. S. and F. N. Andrews.
The estrogenic activity of legume, grass and corn silage.
J. Dairy Sci. 39:81-89. 1956. b.

Richardson, D. F., F. H. Baker, D. L. Good and R. F. Cox.
The value of stilbestrol in beef cattle rations, wintering phase. Kansas Agr. Exp. Sta. Circular 320:50-52. 1955.

Richardson, D. F., F. H. Baker, E. F. Smith and R. F. Cox.
The value of stilbestrol in beef cattle rations-wintering, grazing, fattening phases. Kansas Agr. Exp. Sta. Circular 335:40-45. 1956. a.

Richardson, D., D. L. Mackintosh, J. D. Wheat, C. S. Menzies and R. F. Cox.
The value of stilbestrol in the fattening ration of beef steers. Kansas Agr. Exp. Sta. Circular 335:48-50. 1956. b.

Richardson, D., E. F. Smith and R. F. Cox.
The value of stilbestrol in beef cattle rations. Kansas Agr. Exp. Sta. Circular 335:45-46. 1956. c.

Smith, Walter H., T. Donald Bell, A. B. Erhart and D.L. Mackintosh.
The effect of hormone administration on the feed lot performance, carcass qualities and reproductive organs of feeder lambs. J. Animal Sci. 14:1256-1257. 1955.

Smith, E. F., D. Richardson, B.S. Kock, R. F. Cox and W. E. Stitt.
The effect of spaying and feeding of stilbestrol on the performance of heifer calves on wintering rations. Kansas Agr. Exp. Sta. Circular 335:46-48. 1956. a.

Smith, Max E., Harold E. Scheid and Logan T. Wilson.
Stilbestrol and stilbestrol oxytetracycline combination for steers fattened on corn silage. J. Animal Sci. 15: 1239-1240. 1956. b.

Stitt, Wayne, Eugene.
The value of Stilbestrol for steer and heifer calves on high roughage rations. Master's Thesis. Kansas State College. 1956.

Stob, Martin, F. N. Andrews, M.X. Zarrow and W. M. Beeson.
Estrogenic activity of the meat of cattle sheep and poultry following treatment with sythethic estrogen and progesterone. J. Animal Sci. 13:138-151. 1954.

Stob, Martin.
Fecal elimination of hormones in sheep and cattle treated with sythetic estrogens. J. Animal Sci. 15:990-996. 1956.

Stob, Martin, T. W. Perry, F. N. Andrews and W. M. Beeson.
Residual estrogens in the tissues of cattle treated with diethylstilbes trol, dienestrol, hexestrol and chlortetracycline. J. Animal Sci. 15:997-1002. 1956.

Story, C. D., E. W. Cheng and W. H. Hale.
Metabolism of stilbestrol with lambs. J. Animal Sci. 14: 1257. 1955.

Struempler, Arthur and Wise Burroughs.
Influence of stilbestrol upon digestibility and nitrogen retention in lambs using low and high level protein rations J. Animal Sci. 15:1243. 1956.

Thomas, O. O., R. R. Woodward, J.R. Quensenberry and F. S. Wilson.
Effect of feeding stilbestrol to steers wintered on the range upon subsequent summer gains. J. Animal Sci. 15: 1252-1253. 1956.

Turner, Chas.
Bilogical assay of beef steer carcasses for estrogenic activity following the feeding of diethylstilbestrol at a level of 10 mg. per day in the ration. J. Animal Sci. 15:13. 1956.

Welch, J. A., G.A. McLaren, G.S. Smith, D.C. Shelton and G.C. Anderson.
The influence of diethylstilbestrol urea and biuret upon digestibility and nitrogen metabolism in lambs. J. Animal Sci. 15:1264-1265. 1956.

Whitehair, C. K., Willis D. Gallup and M. C. Bell.
Effect of stilbestrol on ration digestibility and on calcium, Phosphorous and nitrogen retention in lambs. J. Animal Sci. 12:331-337. 1953.

THE USE OF A HORMONE-LIKE SUBSTANCE FOR BEEF CATTLE

by

KENNETH EARL VISSER

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This study was conducted to obtain information on (1) the value of stilbestrol in the wintering ration of beef calves (2) the carry over effect during grazing and fattening, (3) the value of stilbestrol in both the wintering and fattening ration of beef calves, (4) the effect of stilbestrol on feed utilization, and (5) the effect of stilbestrol on carcass grade.

Twenty-seven head of good quality Hereford steer calves averaging 400 pounds at the beginning of the test were divided into three lots of nine animals each on the basis of weight and quality. Lot 1 received 5 mg. of stilbestrol orally per head daily mixed in soybean oil meal the first 56 days of the wintering phase and 10 mg. per head daily the remainder of the wintering phase. Lots 2 and 3 served as controls during the wintering phase. All twenty-seven steers were grazed on good bluestem pasture a period of 92 days. No stilbestrol was fed to any of the lots during the grazing phase. Lots 1 and 2 were fed 10 mg. of stilbestrol per head per day mixed in soybean oil meal during the fattening phase. Lot 3 was the control lot. The steers were graded on foot by an appraisal committee six days before they were slaughtered. Carcass data were obtained on each individual steer at the time of marketing and slaughter.

Results from this experiment indicated that it was economical to feed stilbestrol to calves on a roughage ration.

When the steers that had received stilbestrol during the wintering phase were taken to pasture and stilbestrol was discontinued during the grazing phase, they gained less than did the control lots. This indicated that there was no carry over

effect of the stilbestrol from wintering to grazing. Low gains on grass were to be expected, however, since these calves had made good gains during the wintering phase of the test.

During the fattening phase, stilbestrol fed steers made slightly greater daily gains than the control steers. The average daily gains were 2.44, 2.33 and 2.22 pounds per head per day in lots 1, 2 and 3 respectively during the fattening period.

No noticeable adverse side effects were observed during the experiment due to the feeding of stilbestrol. The treated steers were more efficient in utilization of feed than the control steers. This indicated that it was economical to feed stilbestrol in a fatteing ration. Data from this experiment indicated that the feeding of 10 mg. of stilbestrol per head per day to steers during the fattening phase gave the best results from the standpoint of feed efficiency and side effects. An average of 97 pounds less of ground milo per 100 pounds of gain was required for the treated lots. The control steers had slightly less shrink to market than did the two treated lots.

An appraisal committee had a tendency to grade the treated lots on hoof slightly higher than the control steers. When the carcasses were graded on the rail by a USDA grader the control carcasses graded one-third of a grade higher than the treated carcasses. The control lot had more carcasses that graded choice than both of the treated lots.